WASHING AND RINSING METHOD FOR A WASHING MACHINE

The invention starts from a method for improving the cleansing effect on non-delicate washing which is to be washed in a washing machine comprising a laundry drum which is driven intermittently during the washing and rinsing process in alternating directions of rotation, wherein in one phase the laundry drum is accelerated in one direction of rotation to a first rotational speed significantly above the applicational rotational speed, so-called washing-spinning, and in the other direction of rotation to a second rotational speed significantly below the applicational rotational speed. The applicational rotational speed is that speed at which the items of laundry just begin to adhere to the drum wall as a result of the induced centrifugal force.

Such a method is known from EP 0 618 323 A1. In this method, during the washing and/or rinsing operation the textiles should absorb water at a speed significantly below the applicational rotational speed which is then expelled from the textiles again at a speed significantly above the applicational rotational speed. The speed and direction of rotation is selected for a scoop device which is provided such that this scoop device additionally assists the water absorption of the textiles. Thus, in this known method good wetting of the laundry is achieved. A weakness of this method has an effect especially with large laundry loads. In this case, only weak wash mechanics are exerted on the items of laundry. When the laundry drum is operated at speeds significantly below the applicational rotational speed, the laundry executes a so-called rolling movement. In the known method the wash mechanics, consisting of compression and friction between the individual items of laundry is reduced considerably during operation at speeds significantly below the applicational rotational speed. When the laundry drum is driven above the applicational rotational speed, this is even completely absent since the individual items of laundry adhere firmly to the wall of the laundry drum.

Such or similar methods are suitable for washing especially delicate or handwash-only textiles as a result of the process-dependent reduced wash mechanics.

A method for intensive wetting of laundry is also known from DE 37 41 177 A1. The process sequence described therein reveals a weakness during the

redistribution of items of laundry especially large laundry loads, that is, the specific rearrangement of interior items into the outer area of the laundry batch and conversely during the washing and/or spinning process.

In the known method, reduced wash mechanics is exerted on the laundry to be washed at the expense of an improved laundry wetting. Especially in the case of non-delicate laundry too little cleansing effect is achieved as a result of the reduced wash mechanics. Thus no optimal washing result is achieved. In addition, in the methods described hereinbefore, the laundry is not sufficiently well redistributed when the laundry loads are large and very large. For example, the interior portions of the laundry inside the laundry drum do not reach the outer edge of the drum. Thus, very different mechanics dependent on their respective position is exerted on the individual items of laundry. Within a batch of laundry a very different washing result is thus obtained for interior and exterior items of laundry. In addition, exterior items of laundry frequently clump together as a result of their intensive local removal of water. This effect again results in a reduction of the wash mechanics of individual items of laundry and a non-uniform washing result.

It is the object of the invention to provide an operating mode during the washing and/or rinsing process for the method described initially wherein high wash mechanics is retained to clean non-delicate laundry and good redistribution of the laundry takes place especially with large loads. In addition, the aim is thus to achieve an improvement in the uniform washing effect of a laundry batch and to reduce the consumption of water, washing agent and energy.

This object is solved according to the invention by the fact that within the washing and/or rinsing process the laundry drum is driven in at least one further phase "intensive wetting" and in at least one further phase "high wash mechanics". These phases take place successively at least once within the washing and/or rinsing process. In the "intensive wetting" phase the laundry drum is accelerated in one direction of rotation to a speed significantly above the applicational rotational speed and in the other direction of rotation to a second speed significantly below the applicational rotational speed. In the "high wash mechanics" phase the laundry drum is accelerated in both directions of rotation to

speeds at which the individual items of laundry are strongly compacted and rubbed vigorously against one another.

The advantages of the invention, further embodiment of the invention, the method according to the invention and a washing machine for carrying out the method are described in detail with reference to the sequence examples and exemplary embodiments shown in the drawings. In the figures:

Fig. 1 is a rotational speed diagram for a washing and/or rinsing cycle configured according to the invention,

Fig. 2 is a further example of a washing and/or rinsing cycle shown using a rotational speed diagram and

Fig. 3 is a schematic diagram of the laundry movement of a batch of laundry of an average load at different drum speeds:

a) at about 35 1/min
b) at about 50 1/min
c) at about 100 1/min,

Fig. 4 is a schematic diagram of the laundry movement of a batch of laundry of a large load at different drum speeds:

a) at about 35 1/min
b) at about 50 1/min
c) at about 100 1/min,

Fig. 5 is a schematic diagram of the laundry movement during the redistribution according to the invention of a batch of laundry of a large load:

a) drum speed about 150 1/min
b) turning the drum in the opposite direction at about 35 1/min.

In order to intensify the wetting of the laundry with soap solution, in the method according to EP 0 618 323 A1 the laundry drum is driven during the washing and/or rinsing process in the respectively opposite directions of rotation at different rotational speeds. During one section in which the drum is driven at a speed significantly below the applicational rotational speed, the items of laundry absorb soap solution. In a second section in which the laundry drum is driven significantly above the applicational rotational speed, the soap solution is expelled from the items of laundry again. The released soap solution collects in the soap solution container and at the same time the level of the free soap solution in the container rises. The level thereby increased favours renewed absorption of water or soap solution by the laundry during the subsequent low-speed (e.g. 25 to 40 1/min) rotation of the drum. This speed (scoop speed) is optimised for washing appliances whose laundry drums are equipped with scoop devices. During scooping of the free soap solution, no large laundry mechanics is achieved since the drum speed is too low for this. During the revolution of the drum at a scoop speed, the laundry executes a rolling movement as is shown in Fig. 3a for a half-fully laden laundry drum. Non-delicate textiles can be washed with significantly higher wash mechanics than that acting during the "scooping" described above. Especially in the case of non-delicate textiles, no adequate washing and rinsing performance is achieved despite the good wetting of the textile. Thus, either programme running times must be increased or more washing agent must be used to compensate for the lack of washing performance.

In contrast to the known method, in the method according to the invention the washing and/or spinning process comprises at least one phase (A) of intensive wetting, a phase during which the textile absorbs soap solution and releases it again, and also a phase (B) of high wash mechanics, e.g. drum speed 50 1/min. Phase (B) is characterised in that during rotation of the drum the items of laundry are raised so far that they are then returned to the bottom of the drum again as a result of acceleration due to gravity. This movement sequence of the laundry inside a half fully-loaded laundry drum is shown in Fig. 3b. During this process significantly more mechanics is exerted on the textile than during a rolling movement e.g. during the "scooping" described above. The laundry drum is alternately driven in each direction, that is in so-called reversing operation. The duration and the sequence of the intensive wetting phase, the operation of the laundry drum significantly above and significantly below the applicational

rotational speed, and the duration and sequence of the high wash mechanics phase are selected so that the washing and rinsing performance is increased so far that a short programme running time and/or a reduced usage of washing agent is achieved.

During reversing operation of a half fully-loaded laundry drum a certain regrouping of the laundry is effected. The raising of the laundry is assisted by so-called entrainers affixed to the drum. An entrainer can be constituted by a partially inwardly pulled drum jacket and also by an approximately triangularly profiled plastic part affixed to the drum jacket. Entrainers have a symmetrical or asymmetrical cross-section. Laundry drums fitted with asymmetrical entrainers are frequently driven in reversing mode at a different speed for each direction of rotation (e.g. 50 and 60 1/min). In a fully loaded laundry drum there is not sufficient free space inside the drum in which the laundry regroups in reversing operation. The operation of a fully loaded laundry drum during "scooping" is shown in Fig. 4a and during the high wash mechanics phase in Fig. 4b. In contrast to operation with a half fully loaded laundry drum, the individual items of laundry impede each other in their movement so that during the scooping operation and the high wash mechanics phase the laundry no longer regroups.

If the speed of the laundry drum is significantly above the applicational rotational speed and at the same time significantly below the resonance speed, especially with large laundry loads this speed is not sufficient to severely compress the laundry batch. That is to say, a relatively weak force is exerted on the interior items of laundry and the removal of moisture from these textiles will thus be less than in the case of the exterior textiles. For explanation, the compression of the laundry in a laundry drum driven at a speed significantly below resonance (e.g. 100 1/min) is shown in Fig. 3c for a half load and in Fig. 4c for a full load. Furthermore, the space left free in the fully loaded laundry drum is so small that no redistribution of items of laundry from inside to outside can take place. During the operating phases of intensive wetting and high wash mechanics no sufficient redistribution of laundry is achieved in a fully loaded laundry drum. The significantly reduced redistribution of the laundry in the drum has the result that the laundry batch is non-uniformly wetted and mechanically treated as a result of which the textiles in this batch of laundry are non-uniformly cleaned.

In an advantageous further development of the method according to the invention, a significantly higher speed (e.g. 150 1/min) is selected for the "wash-spinning" in order to compress the batch of laundry significantly better, as shown in Fig. 5a. In addition, a larger free area in the drum space is also provided as a result. As a result of the subsequent rotation of the laundry drum in the opposite direction, the exterior falling items of laundry roll into the inner area. This rolling process of the items of laundry is illustrated schematically in Fig. 5b at a drum speed of 35 1/min. The turning of the laundry drum in the opposite direction advantageously supports the rolling of the laundry into the interior of the laundry batch. Furthermore, it is desirable to restart directly after the drum has come to rest in order to counteract uncontrolled collapse of the laundry without further regrouping.

In order to avoid overstressing of the drive or the soap-solution container assembly, in an advantageous embodiment of the invention, the developing imbalance is monitored especially during the wash-spin section and when a predetermined limiting value is exceeded, the wash-spin operation is interrupted. Means for determining the soap-solution container vibration path, the motor current, torque, the speed or its time derivatives are suitable, for example, for determining the imbalance.

During the wash-spin operation, dipping of the inner drum into the soap solution located freely in the soap-solution container should be avoided to prevent any additional foam formation. A means for monitoring the foam is advantageously used and when a predetermined limiting value is exceeded, the wash-spin operation is interrupted. Means for determining the hydrostatic pressure, the motor current, torque, the speed or its time derivatives are suitable, for example, for determining the foam located in the soap-solution container. If the monitoring means is suitably selected, e.g. a device for monitoring engine speed, imbalance and foam monitoring can advantageously be combined.

As has already been addressed in the previous reasoning, the methods for rearrangement of laundry are highly dependent on the loading quantity. In addition to the quantity, the absorbency and the type of textile should also be taken into account when designing the process. Depending on the use, a user of a washing appliance inserts a broad spectrum of different batches of laundry and

quantities in washing appliances. Thus, means for determining the type and/or quantity of laundry are advantageously used in order to set the speeds (n1 to n3), section times ((Δt1 to Δt6) and the durations (ΔtA, ΔtB)and sequence of the intensive wetting and high wash mechanics phases (A and B). Force or distance sensors integrated in the washing appliance can be used, for example, as suitable means for determining the laundry weight. These sensors are arranged in the appliance or on the spring-mounted vibration system (soap-solution container assembly) such that a change in the known weight of the vibration system or the known rest position can be determined by the additional weight of the laundry. The quantity, type and absorbency of the textiles to be washed can also be determined from a determination of the soap solution absorbed by the laundry (e.g. using a flow or pressure sensor) and from the time behaviour relating thereto.

By their programme selection (e.g. boil wash, easy-care, wool) the user of the washing machine specifies how sensitive are the textiles to be washed. It has proved to be particularly advantageous to implement the drum speed (n1 to n3), section times ((Δt1 to Δt6) and the durations (ΔtA, ΔtB) and sequence of the "intensive wetting" (A) and "high wash mechanics" (B) phases depending on the choice of programme to adapt the wash mechanics to the sensitivity of the textiles.

In the example shown in Figure 1 the drum, which has a diameter of 470 mm, is gently accelerated clockwise to a speed (n3) of +50 1/min, remains at this speed for a duration Δt1 and is then returned to a speed of 0 1/min. After a stoppage time Δt2, the process is repeated with the drum rotating anti-clockwise. The residence time Δt3 during anti-clockwise rotation can differ from the corresponding residence time Δt1 of the clockwise rotation. This reversing process is repeated for the duration ΔtB of the high wash mechanics phase (B). Following this phase, the drum is gently accelerated clockwise to a speed (n1) of +150 1/min, remains for a duration Δt4 at this speed and is then returned to a speed 0 before being transferred directly to the anticlockwise phase at a speed (n2) of, for example, 35 1/min for the duration Δt5. After a stoppage time Δt6, the sequence is repeated until the duration ΔtA of the intensive wetting phase (A) is reached. A high wash mechanics phase (B) is then implemented. The specified time duration (Δt1 to Δt6, ΔtA and ΔtB) can be varied in any possible combination and in extreme cases can individually or all be zero.

Compared with Figure 1, Figure 2 shows a slightly different speed profile for the high wash mechanics phase (B). In this case, the clockwise and anticlockwise speeds differ, for example matched to asymmetrical entrainers.

The specified speeds n1, n2 and n3 can be freely selected within the limits specified by the claims. In order to achieve optimum effects, fixed machine parameters must also be taken into account for the choice of speed, which are obtained from the dimensions of the laundry drum, its flooding holes, the entrainers, the scooping device and the resonance speed. The radius of the laundry drum is especially crucial when selecting the speed since the radius fundamentally determines the applicational rotational speed. Thus, the advantageous nominal values of the speeds are predefined by predefining the circumferential speed of the laundry drum.

A washing machine comprising a speed control device for the drive motor of the laundry drum is provided according to the invention for application of the method. The speed control device can generate control signals for the drive motor such that in the washing and/or rinsing process the laundry drum is intermittently driven in alternating directions of rotation at respectively different speeds in at least one intensive wetting phase (A) and at least one high wash mechanics phase (B). In addition to the speed control device, the washing machine can also be fitted with further control devices such as, for example, control electronics or power electronics. These control devices are interconnected by means of data or bus lines. For example, a control command or a control command sequence can be generated by power and/or control electronics and transmitted to the speed control device via the data or bus line.

This control command or control command sequence has the effect that the speed control device can generate a control signal for the drive motor such that the laundry drum is driven in the washing and/or rinsing process in at least one intense wetting phase (A) and at least one high wash mechanics phase (B).

Variable values, such as load quantity, type of laundry, wash programme, laundry imbalance and foam formation can advantageously also be taken into account and influence the choice of speeds and the residence times if the washing machine contains the devices described above for determining and evaluating the variable

values. The speed control device is configured such that the formation of control signals by the speed control device for the drive motor is dependent on these variable values. For this purpose the devices, e.g. sensors, for determining the variable values are either connected directly to the speed control device or indirectly by means of data or bus lines.

The explanations put forward above disclose a method and means for implementing the method which bring about a uniform washing effect very close to the optimum and within a laundry batch and a reduction in the water, washing agent and energy consumption is achieved.